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(दूसरा पुनरीक्षण)

Indian Standard

SILICA REFRACTORIES FOR COKE OVEN — SPECIFICATION

(Second Revision)

ICS 81.080

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

August 1996

Price Group 5

Refractories Sectional Committee, MTD 15

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Refractories Sectional Committee had been approved by Metallurgical Engineering Division Council.

This standard was first published in 1968 and subsequently revised in 1972. While reviewing the standard in the light of experience gained during these years, the committee decided to revise it to bring it in line with the present practices being followed by the Indian Industry.

In the present revision, the following changes have been made:

a) Chemical composition and physical properties of silica refractories have been modified.

b) Permissible variation for various dimensions, allowable surface and edge cracks, allowable edge and corner breakages and melted out holes have been specified.

c) Description of test apparatus and test procedure for measuring breakage of corner and edges has been appended in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical value (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SILICA REFRACTORIES FOR COKE OVEN — SPECIFICATION

(Second Revision)

1 SCOPE

This Indian Standard (Second Revision) covers the requirements for silica refractories for coke oven of height up to and including 5 metres.

2 REFERENCES

The following Indian Standards are the necessary adjuncts to this standard:

IS No.	*Title*
1387 : 1993	General requirements for the supply of metallurgical materials (*second revision*)
1527 : 1972	Methods for chemical analysis of high silica refractory materials (*first revision*)
1528	Methods of sampling and physical test for refractory materials:
(Part 1) : 1980	Determination of pyrometric cone equivalent (PCE) or softening point (*second revision*)
(Part 2) : 1974	Determination of refractoriness under load (*first revision*)
(Part 4) : 1974	Determination of cold crushing strength (*first revision*)
(Part 6) : 1974	Determination of permanent change after reheating (*first revision*)
(Part 7) : 1974	Method of sampling and criteria for conformity (*first revision*)
(Part 8) : 1974	Determination of apparent porosity (*first revision*)
(Part 9) : 1980	Determination of true specific gravity and true density (*second revision*)
(Part 11) : 1993	Determination of warpage (*second revision*)
(Part 12) : 1974	Determination of bulk density (*first revision*)
4041 : 1987	Glossary of terms relating to refractory materials

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 4041 : 1987 shall apply.

4 SUPPLY OF MATERIAL

4.1 General requirements relating to the supply of the refractories shall be as laid down in IS 1387 : 1993.

4.2 The refractories shall be compact, of homogenous texture, burnt evenly throughout, having no soft corner, have sufficient mechanical strength and have good ring when struck with a small hammer.

4.3 Physical defects (both internal and external) like cracks, voids and other flaws like deflection, corner chips melted out holes etc. shall be within the specified limits.

4.4 Cutting/grinding/dressing of the finished faces coming in contact with coke side or gas space is not permitted. For cover faces such as faces coming in contact with mortar may be permitted with mutual agreement between the purchaser and the supplier.

5 CHEMICAL COMPOSITION

When tested in accordance with IS 1527 : 1972, the material shall comply with the following requirements:

Silica (SiO_2), percent, *Min* 94.0

Calcium oxide (CaO), percent, *Max* 2.5

Aluminium oxide(Al_2O_3), percent *Max* 1.5

6 PHYSICAL REQUIREMENTS

The refractories shall conform to the requirements given in Table 1.

7 DIMENSIONAL TOLERANCES

7.1 Toleance on sides of the product shall be as given in Table 2.

7.2 Allowable breakage in edges and corners shall be as given in Table 3.

7.2.1 Number of permissible breakages shall be at:

Coke side	—	one
Gas side	—	two
Side covered with brick	—	three

The total number of corner breakages should not be more than 3 in any brick.

7.2.2 Description of the test apparatus and test procedure for measuring breakage of corners and edges of refractories is given in Annex A.

7.3 Dimensions for melted out holes shall be as given in Table 4.

7.4 Cracks on the brick surface are allowed only if they fall into the following categories:

a) Width 0.1 to 0.25 mm — Allowed only if the fine cracks do not cross over more than one edge, that is from one surface to the other surface.

The length of the cracks on any side shall not exceed 35 mm. Netting is not allowed.

b) Width 0.25 to 0.5 mm — Not allowed for coke side of the brick. These cracks are allowed on gas side covered with bricks work only if:

i) they are not more than two in number,

Table 1 Physical Requirements

(*Clause* 6)

Sl No.	Characteristics	Requirements			Test Method (Ref to Part of IS 1528)
		Sole Brick	Pressed Brick	Pnuematic Ramming/Hand Moulding	
(1)	(2)	(3)	(4)	(5)	(6)
i)	Pyrometric cone equivalent, standard cone (ASTM) number, *Min*	31	31	31	Part 1
ii)	Refractoriness under load (2 kg /cm^2) t_a°C, *Min*	1 650	1 650	1 650	Part 2
iii)	Cold crushing strength, kg/cm^2, *Min*	500	300	250	Part 4
		Average of 5 results No value below 425	Average of 5 results No value below 250	Average of 5 results No value below 200	
iv)	Apparent porosity, percent, *Max*	17	23	25	Part 6
v)	True specific gravity, *Max*	2.35	2.35	2.35	Part 9
		Average of 5 results No value above 2.35	Average of 5 results No value above 2.36	Average of 5 results No value above 2.36	
vi)	Permanent linear change after reheating at 1 450°C for 4 h, percent, *Max*	+0.4	+0.4	+0.4	Part 6
vii)	Reversible thermal[1] expansion at 1 000°C, percent, *Max*	1.3	1.3	1.3	—
viii)	Bulk density, g/cm^3, *Min*	1.85	1.76	1.73	Part 12

NOTE — Purchaser should indicate list of items in each category which shall be strictly adhered to by the supplier.

[1] For method of test, refer Annex B.

Table 2 Dimensional Tolerances

(*Clause* 7.1)

All dimensions in millimetres.

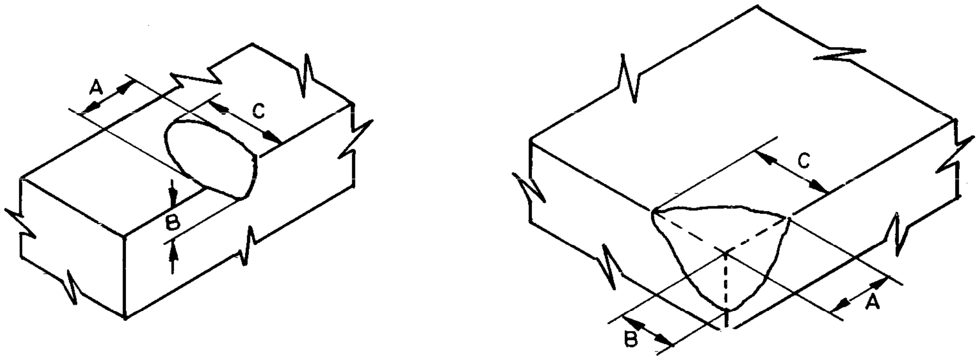
Sl No.	Characteristics		Tolerance, mm
(1)	(2)		(3)
i)	Size	Up to 100 mm	+ 1 − 3
		Over 100 up to 350 mm	+ 2 − 3
		Over 350 mm	± 4
ii)	Deflection[1] in mm, *Max*	At side covered with bricks and coke side	+ 2
		At the gas side	+ 3
iii)	Apertures and holes	Up to 100 mm	+ 3 − 1
		Above 100 mm	+ 3 − 2

NOTE — Other than above, special tolerances if required, may be furnished by the purchaser, to be mutually agreed upon.

[1] To be determined as per IS 1528 (Part 11) : 1993.

Table 3 Allowable Breakages in Edges and Corners

(*Clause* 7.2)



Brick Face	Edge Breakage, mm			Corner Breakage, mm		
	A	B	C	A	B	C
Coke face	10	5	15	10	10	15
Gas face and surfaces of bricks used in coke face which are covered with brick work	30	10	30	15	15	25
Other faces	30	30	30	30	20	20
				or 20	30	20
				or 20	20	30

- ii) they are not more than sixty mm in length,
- iii) they do not cross more than one edge, and
- iv) netting is not allowed.

c) Cracks of width more than 0.5 mm are not allowed.

NOTES

1 Cracks of width up to 0.1 mm are not considered.

2 Cracks of width 0.1 mm to 0.5 mm should not exceed half the length of the brick in the same direction on the same plane.

3 Surface of brick with tongue and groove is considered as one.

8 SAMPLING

8.1 Sampling for chemical and physical tests.

8.1.1 *Lot*

In any consignment a lot for chemical and physical test shall generally consist of bricks of one or more shapes of the same zone of brick work of the same specifications and manufactured by the same firm under similar conditions of production. The brick shape in a lot shall have comparable unit weight. The weight of a lot shall be 25 tonnes maximum.

8.1.2 The scheme of selection of representative random samples from each lot/lots as per **8.1.1** above shall be as per **3.3** of IS 1528 (Part 7) : 1974.

8.2 The test specimens which are required to be subjected to various tests shall be prepared in accordance with the details of test specimen given under relevant Indian Standard.

8.3 Criteria for Conformity

8.3.1 For ascertaining the conformity of the lot of finished products, the criteria for conformity shall be as per 4 of IS 1528 (Part 7) : 1974.

8.3.2 One sample for every 200 tonnes comprising of 8 lots of 25 tonnes each shall be tested for reversible thermal expansion as per method given in Annex B.

8.4 Bricks supplied shall have both minus and plus tolerances. They are not expected to fail consistently on plus or minus size of the specified dimension except for small quantity orders. Brick and the specified dimensions on which balancing is required shall be indicated by the purchaser. Percentage of plus or minus tolerances is to be mutually agreed between purchaser and supplier. Brick with plus and minus tolerances shall be marked out separately for easy identification.

NOTE — The brick for a particular battery shall be manufactured using same source of raw material which is expected to give a uniform rate of reversible thermal expansion.

9 MARKING

The refractories shall be clearly marked with the manufacturer's name or trade mark.

9.1 BIS Certification Marking

The material may also be marked with the Standard Mark.

9.1.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Table 4 Dimensions for Melted Out Holes

(*Clause* 7.3)

Sl No.	Location	Hole Dimensions	
		Diameter mm, *Max*	Depth mm, *Max*
i)	For coke side	5	3
ii)	For gas side	10	3
iii)	For side covered with brick work	15	5

NOTES

1 Number of melted out holes of 4-5 mm diameter for coke side should not be more than three.

2 Number of melted out holes upto 4 mm diameter are not considered.

ANNEX A

(*Foreword* and *Clause* 7.2.2)

DESCRIPTION OF THE APPARATUS AND ITS USE FOR MEASURING BREAKAGE OF THE CORNERS AND EDGES OF THE REFRACTORIES

A-1 TYPES OF APPARATUS

The apparatus are manufactured in four types : I, II, III and IV type. Types I and III are meant for rectangular cross-section of the items and are used in all directions. Types II and IV are used for items of irregular shape having dihedral angles of 45 to 135° formed with two straight lines.

A-2 TYPE I APPARATUS (Fig. 1 and Fig. 2)

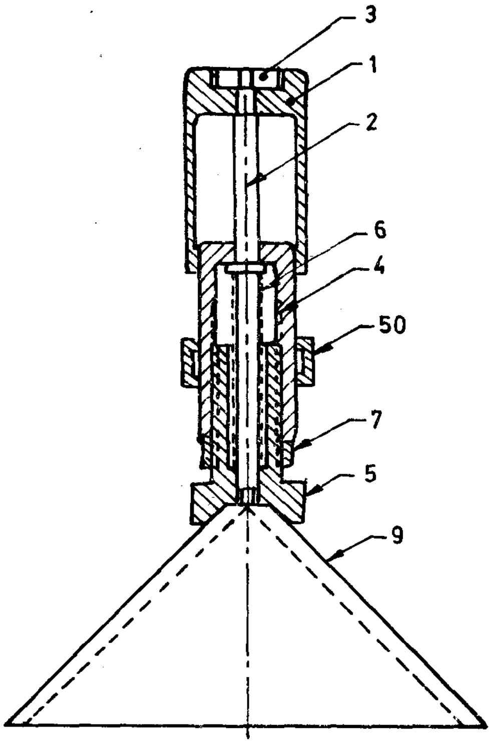


FIG. 1 APPARATUS (TYPE 1) FOR MEASURING THE BREAKAGE OF CORNERS OF THE REFRACTORIES

A-2.1 Construction

The apparatus consist of a hollow pyramid (9) consisting of three right angled triangles and when it is placed on the corner of the item, it abouts against the edges of the item. A depth measuring device is permanently fitted to this pyramid. The device consists of the main tube having threads on its surface (5), a coupling (4) screwed on this tube; the coupling has a millimetre scale inscribed on it and can be fixed in the required position with the help of a locking nut (7), a movable steam of diameter 3 mm (2) having a neck (chamfering) at the end upto a diameter of 2 mm, a cap (1) screwed on the coupling and fixed with locking nut (3).

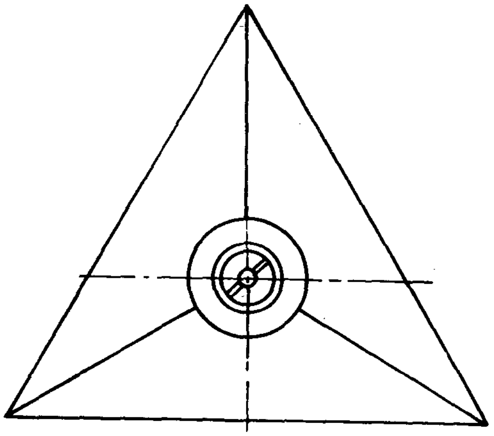


FIG. 2 VIEW OF POINTER 'A'

When the cap is pressed with a finger, the stem freely slips in the holes of the main tube and coupling, and its end goes deep into the hollow pyramid forming and angle of 45° with each edge of the pyramid; when the stem and the cap connected to it, the cap pushes the springy split ring having an indicator for taking the reading (50). The stem and the cap come back to their initial position with the help of a spiral spring (6), the lower end of which is fixed at the bottom of the tube and the upper end in the circular thick portion of the stem.

For assembling the components of the measuring device, the coupling is screwed on the main tube till the platform of the lower end of the stem coincides with the vertex of the inner solid angle of the pyramid. After this, the coupling is fixed with a locking nut.

The pyramid is made of steel sheets of 2 mm thickness and the spring and the stem are made of steel wire. The end of the stem is hardened. The rest of the parts are made of brass or steel.

A-2.2 Test Procedure

For using the apparatus, the ring having the indicator is pulled back fully into the cap. The apparatus is held by the base of the measuring device with thumb and middle finger of the right or left hand and set tightly on the corner of the item. Then the cap or the stem is pressed with the help of forefinger. The depth of movement of the stem is determined from the displacement of the indicating ring along the millimetre scale of the coupling, that is the depth of breakage of the corner is determined in millimetres and at the same time it is determined to what extent the item with respect to breakage of the corners conforms to the norms specified in the standards.

If the end of the stem has worn out with time, the locking nut is losened and the coupling is screwed on the tube till the stem acquires the required position. After this, the locking nut is again tightened. If the stem has considerably worn out and the further adjustment of the apparatus is not possible, then the stem is replaced.

A-3 TYPE II APPARATUS (Fig. 3 and Fig. 4)

A-3.1 Construction

The depth measuring device described for Type I is fixed on the base of the apparatus at an angle of 135°. The base consists of two plates. The outer plate (33) is for fastening the depth measuring device and two extensible side piece (38). With the help of two brackets (39) the side pieces are extended upto an angle of 135° using thumb and middle finger. In this position the apparatus gets pressed by the inner plate of the base (36) to the oblique angled side of the item, after which the side pieces get pressed to two other sides. With the help of two bars (19) which are hinged with screws (31) with the side pieces and hinged to each other with screw (26) which passes through the slot along the center line of the outer plate, the depth measuring device is installed in symmetry with the lateral sides of the angle of any value within 45-135°.

A-3.2 Test Procedure

After installing the apparatus the depth of the breakage of the corner is measured by the method given at **A-2.2**.

A-4 TYPE III APPARATUS (Fig. 5 and Fig. 6) AND TYPE IV APPARATUS (Fig. 7 and Fig. 8)

A-4.1 Construction

Two types of measuring devices are used for measuring the breakage of the edges. Type III apparatus is used for items of rectangular cross-section (Fig. 5 and Fig. 6) and type IV apparatus (Fig. 7 and Fig. 8) for items with oblique angles. The depth measuring device differs from the one described above by having a disk of diameter 10 mm screwed on its protruding end. A plate bent at right angle and having measuring device holder soldered on its serven as a base for type III (Fig. 5 and Fig. 6). The base of type IV consists of an iron scale and two lateral braces, which symmetrically install the apparatus on the item (with the help of two bars and a slot in the guiding side arm of the scale).

A-4.2 Test Procedure

The apparatus is placed on the broken side of the item in such a manner that the disk of the measuring device fits at the deepest point of breakage. The depth of the breakage of the side is measured by the method described at **A-2.2**.

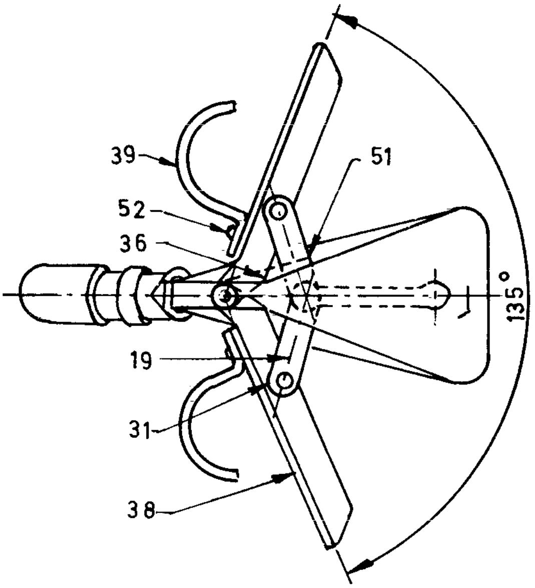


Fig. 3 Apparatus (Type II) for Measuring the Breakage of Corners of the Irregular Shaped Refractories

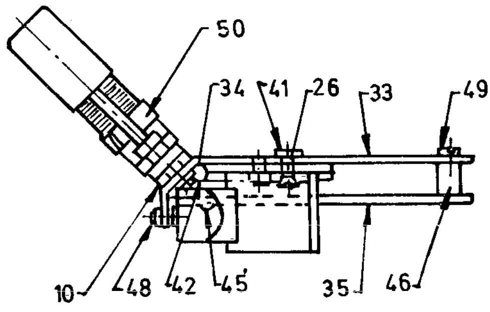


Fig. 4 Apparatus for Measuring the Breakage of the Corners of Refractories

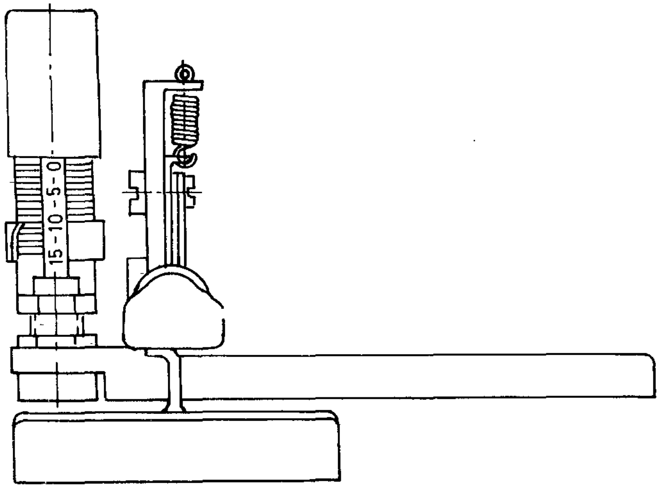


FIG. 5 APPARATUS (TYPE III) FOR MEASURING THE BREAKAGE OF THE SIDES OF REFRACTORIES

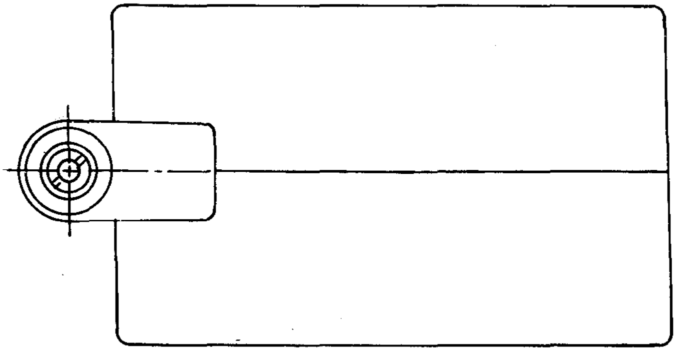


FIG. 6 APPARATUS (TYPE III) FOR MEASURING THE BREAKAGE OF THE SIDES OF REFRACTORIES

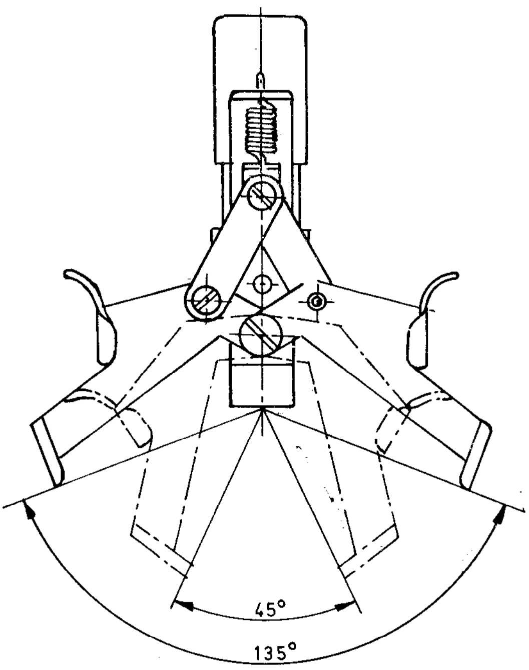


FIG. 7 APPARATUS (TYPE IV) FOR MEASURING BREAKAGE OF THE SIDES OF REFRACTORIES

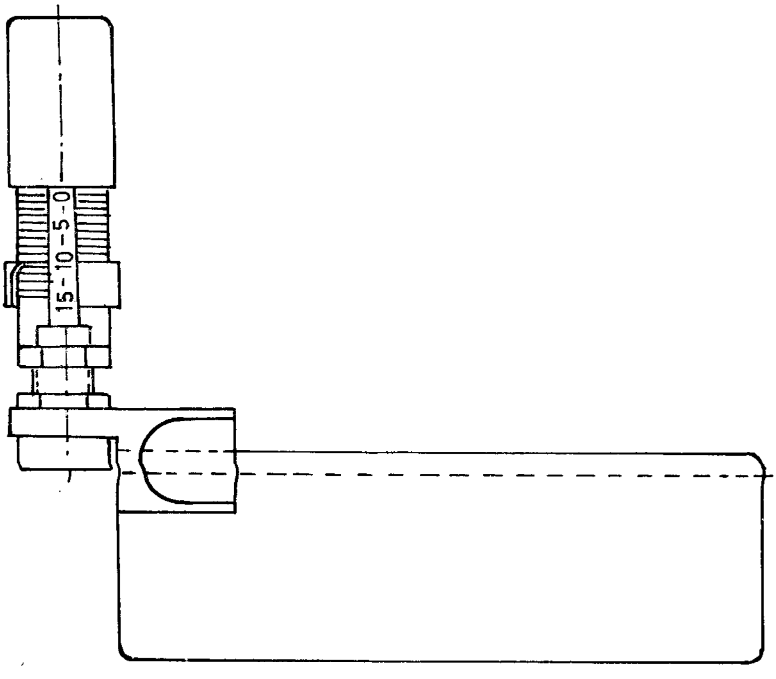


FIG. 8 APPARATUS (TYPE IV) FOR MEASURING BREAKAGE OF THE SIDES OF REFRACTORIES

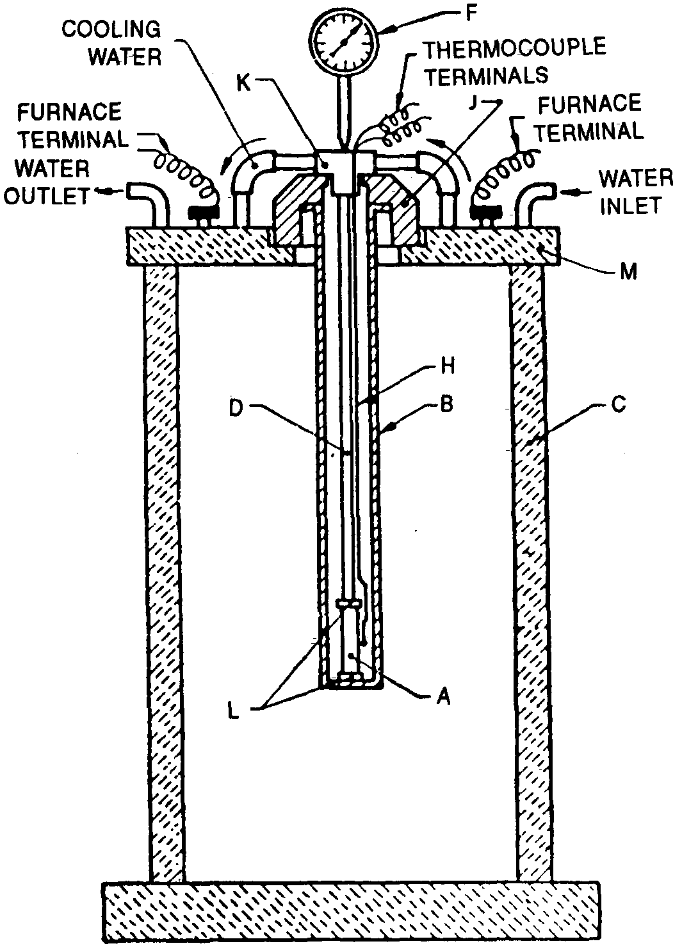
ANNEX B

(*Table* 1 *and Clause* 8.3.2)

METHOD FOR DETERMINATION OF REVERSIBLE THERMAL EXPANSION AT 1 000°C

B-1 TEST APPARATUS

The apparatus to be used is illustrated in Fig. 9. It consists of a cylindrical electric furnace of 500 W capacity placed vertically, a fused silica tube closed at one end and centrally suspended within the furnace from top, and a fused silica rod for transmitting the expansion or contraction of the sample. A direct dial gauge of 1.0 cm range with the finest graduation of 0.01 mm is used for measuring the linear change of the specimen. The furnace top is covered with a metallic plate having a central grooved seat for metallic flange fitted to the open end of the fused silica tube. This arrangement helps in keeping the tube exactly vertical as well as in the center of the furnace. The expansion of the test specimen is transmitted through the metallic block to the dial gauge which accurately fits in the flange on the tube. All these metallic parts are cooled by running water during the test. A thermocouple is inserted in the tube so that the hot junction touches the middle of the test specimen.



A — Test piece
B — Fused silica tube
C — Furnace
D — Fused silica distance rod
F — Dial gauge
H — Thermocouple
J — Metallic flange
K — Metallic block
L — Fused silica disc
M — Metallic plate

FIG. 9 DIAL GAUGE APPARATUS FOR THE DETERMINATION OF REVERSIBLE THERMAL EXPANSION

B-2 CALIBRATION

To allow for any temperature variation between the outside silica tube and the specimen, the apparatus shall first be calibrated,. With a 50 mm test piece of fused silica, a calibration test shall be carried out at the standard rate of heating to 1 000°C and any deviation from the zero reading on the dial gauge shall be noted. The expansion figures obtained in all subsequent test with the apparatus shall be corrected by addition of the difference between the dial reading at a given temperature during the calibration test and the true expansion of 50 mm test piece of fused silica at that temperature.

B-3 TEST PROCEDURE

Measure the length of the test specimen accurately by slide calipers. Place the test specimen inside the fused silica tube in between the two fused silica discs so that the specimen is not displaced during the test. Place the fused silica rod on the upper fused silica disc on top of this specimen. Introduce a suitable thermocouple (for example, platinum/platinum-10 percent rhodium) within the tube so that its hot junction is almost at the center of the specimen. Place carefully the metallic block into the metallic flange on the fused silica tube so that the whole set up of the specimen, tube discs, rod, etc is absolutely free in movement. Put this assembly on the cover compression on the metallic block for recording the expansion or contraction. Start heating the furnace and control the rate of heating at 3 to 4°C per minute. The thermocouple shall be connected to a temperature recording device. The temperature along with the reading of the dial gauge shall be noted every 5 minutes.

B-4 REPORT OF THE RESULT

The dial gauge reading at 1 000°C corrected according to calibration data gives linear change for the sample and shall be expressed as percentages of the original length of the specimen. If necessary, a graph relating to expansion and temperature may also be plotted.

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Amendments Issued Since Publication

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